causing the thread attached to the ball to form with the vertical an angle of from twenty to thirty degrees.

Denoting by θ the coefficient corresponding to that ball, and by δ the observed angle, the surface velocity was found by the ordinary formula $X = \theta \sqrt{\delta}$.

I have known cases where engineers, with a mere knowledge of the fall per mile in a river, and the sectional area, taken at one point only, have, from such very insufficient data, endeavoured to compute the discharge. For the usual formula, by Eytelwein, from which have been derived the tabulated quantities in Beardmore's Hydraulic Tables, and other works, is only applicable under the following conditions, which never occur unless in carefully constructed artificial channels: viz.

Unchanging sectional area.

Unchanging wetted perimeter.

If on the length corresponding to the fall, a great number of cross sections had been taken, so as to admit of a *mean sectional area,* and *mean perimeter of the water contour* being deduced therefrom, then of course a rough approximation to the discharge could have been computed.

Many instances might be cited of disappointment attendant on the completion of hydraulic works, owing to the preliminary calculations having been made on erroneous principles. For instance, when the works for conducting water into Edinburgh were completed, the quantity of water delivered was only one-sixth of the quantity estimated by the designer of the work, although he himself acknowledged that the work had been executed in strict accordance with his plans.

ART. XIX.—*On the Primary Upheaval of the Land round Melbourne, and the recent Origin of the Gypsum or Sulphate of Lime in the great swamp between Batman's and Emerald Hills, Flemington, Williamstown, and Melbourne, illustrated by a large number of Specimens from that Locality. By* WILLIAM BLANDOWSKI, ESQ.

THE land which now constitutes the colony of Victoria owes its origin to the same mighty convulsion which upheaved the Australian Alps. Beginning where those mountains cross the latitude of 37°, eruption followed eruption in rapid succession, the plutonic agency constantly advancing westward,

and with but little deviation from that parallel, thus forming the different granite ranges throughout the country. This mighty power, however, ultimately exhausted, a long period of comparative quiesence ensued, and the mud which was hitherto in mechanical combination with the agitated waters, was deposited on the bed of the now placid ocean; thus was formed the clay-slate strata of the present era. By some internal causes submarine volcanoes again broke forth through the crust of the earth; the first eruption of this nature was apparently in about longitude 145°, and after successively extending the sphere of its action over the whole country, finally became extinguished beneath the ocean. The last of these convulsions, there is reason to surmise, occurred near Mount Benson, in South Australia.

The most important result of this volcanic period, is the existence of the basalt, or as some English geologists term it, the trap formation. The rocks of this class are composed principally of felspar and hornblende, or augite, and when in a molten state, bear in many respects, a near resemblance to glass: hence the reason of the great frequency of the trap formation on our extensive plains, which were rapidly covered with the overflowing liquid mass. An enormous volume of steam generated in the interior of the globe, together with the constituent gases resulting from the actual decomposition of the sea water, were discharged through the crater, greatly assisting the volcanic power in ejecting the burning matter. Assuming the degree of heat necessary to liquify the basalt, to be identical with that of glass, we might thereby estimate the depth at which the former becomes fluid, in other words, ascertain the thickness of the solid crust of the earth. Now 2650° Fahr. (the temperature at which glass liquifies) would require, (according to the annexed table, exhibiting the increased heat at the several depths named, and which are the more to be depended upon, as they are the results of actual borings taken for the purpose, by the Governments of Prussia and the Canton of Geneva, Switzerland), a depth of 105,000 feet, or twenty miles nearly. This depth, which at first sight appears truly enormous, would scarcely equal the thickness of a coat of varnish on a globe of three feet in diameter.*

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* The Austrian Government caused twenty-seven borings to be made for the same purpose. No practical results could be expected from these deep and expensive sinkings; they were undertaken for the pure love of science, and afford an example which must excite shame in us for refusing to make a few borings in order to discover the real value of our coalfields.

Borings through Limestone strata at Rudersdorf, near Berlin, in Jan., 1833. Surface 180 feet above the sea level.

DEPTH. E. Feet.	TEMP. FAHR. Degrees.
104.	27·03
209.	27·82
313.	34·45
417.	36·57
521.	37·63
626.	39·22
730.	42·14
834.	45·05
918.	48·23

Borings at Geneva. Surface, 299 feet above level of Geneva Lake.

DEPTH. Feet.	TEMP. FAHR. Degrees.
31.	22·26
104.	23·32
156.	24·38
208.	25·18
260.	26·50
313.	27·83
365.	28·89
417.	30·21
460.	31·00
521.	32·33
573.	33·39
626.	34·72
	35·78
709.	36·57

Showing a gradual increase of temperature with the depth, being about two and a half degrees every hundred feet.

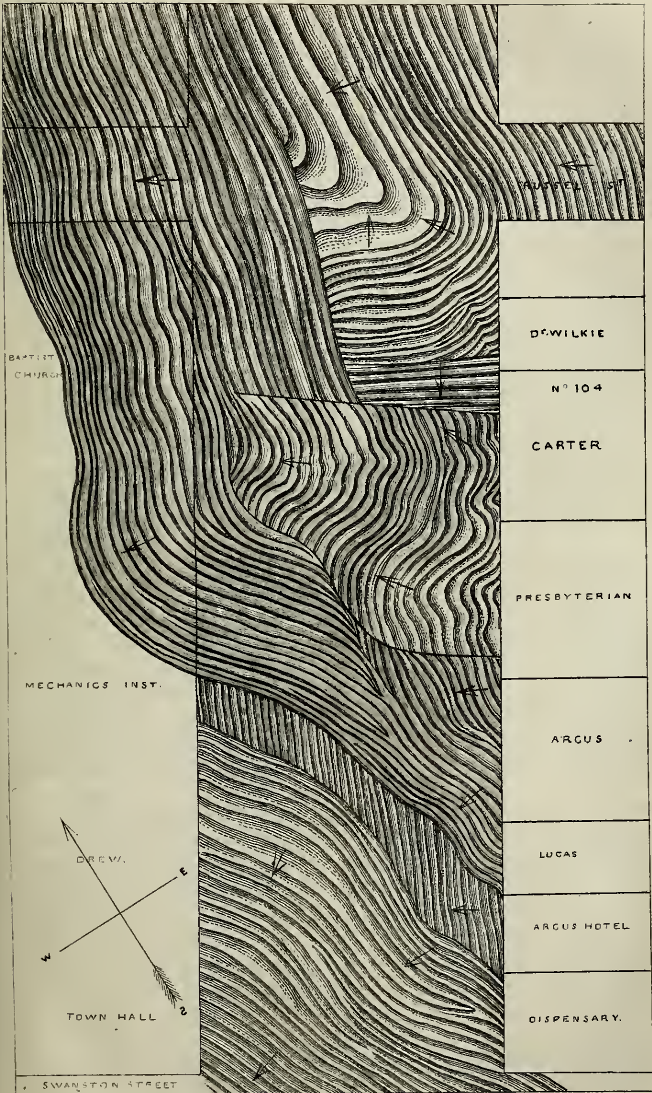
The decomposition of the basaltic rocks produces the rich alluvial soil which covers so large a portion of the country, and renders its agricultural capabilities of so striking a nature. as induced its earliest explorer (Major Mitchell) to bestow upon it the appropriate title of Australia Felix.

The strata eastward round the City of Melbourne consists of micaceous clay slate, frequently of a siliceous or quartzy nature, surrounded and partly overlapped by the trap; they are very strongly compressed, the evidences of which are especially manifest before the Argus Office, in Collins Street, between Swanston and Russell Streets, to the westward, and which seems to be the point at which the great volcanic power, the cause of this compression, was suddenly checked; and in Gisbourne Street, connecting the reservoir with the waterworks, eastwards. (*Vide plate.*) The gases and fluids confined within the earth, forcing their way with irresistable power through the present great swamp included between the localities named in the commencement of this paper, and which then composed the bed of the ocean, moved bodily eastward the whole strata (all more or less in a plastic state), but owing to the tremendous hydraulic pressure exerted by the superincumbent water, the movement received a violent check, resulting in a powerful compression of the strata on the spot where the Rev. A. Morison's and Dr. Wilkie's houses now stand. The

GEOLOGICAL SKETCHES OF VICTORIA

COMPRESSED STRATA IN COLLINS STREET

MELBOURNE.



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motion of the strata being thus arrested, the volcanic power expended itself in upheaving them from the bed of the ocean, the higher portions of land eastward of Elizabeth Street, being thus elevated above its surface. The lava however, not yet cooled, and still subjected to a considerable hydraulic pressure (which is manifest from the occurrence of porous discoloured basalt, below the dense black basalt which is found cropping out from the surface in so many localities,) spread itself over the country by means of the numerous gulleys which already existed beneath the waters of the ocean. One of these ancient channels leads from Flemington to Collingwood, between the Botanical Gardens and Government Paddock, thence beneath Prince's Bridge, towards Emerald Hill. The two varieties of basalt just mentioned, owe their specific characters either to hydraulic pressure in the manner described above, or otherwise are derived from the union of silica and calcium in a molten state; when these ingredients are combined in quantities such that the ratio of the oxygen of the calcium, to the silica be as 1·2, or even 1·3, to unity, a crystalline mass is produced, *resembling dense basalt;* but when the proportion is 1·4, a *porous* matter similar to amygdaloidal basalt is obtained.

Such is my explanation of the primary cause of existence of the extensive basalt formation in the country north and west of Melbourne, and between Flemington and Williamstown. The same theory applies to the whole district between Melbourne and Mount Macedon, as also between Mount Alexander and the new Sydney Road; in fact I was led to form this theory while travelling from Mount Gambier on the frontier of South Australia, where the proofs of its correctness are strongest, becoming fainter as the traveller progresses eastward.

The crater, though still buried beneath the ocean, retained its tremendous power for a considerable time, but was finally overpowered and extinguished by the agitated sea, which pouring into the crater, and becoming comparatively calm, deposited in it a vast quantity of mud and sea weed; ultimately a placid lake as it were, rested on the bosom of the extinct volcano, and innumerable multitudes of shell fish found in it a secure harbour in which they could, without molestation, propagate their species. The Yarra and Salt Water Rivers however, again disturb the tranquility of the scene. Each directing its course to the lake, their united current sweeping over it, eventually filled up the crater with alluvial deposit, and entirely buried the marine animals which had found a

quiet retreat in its waters, being cut off from the sea by an effectual barrier, formed on one side by the waste materials carried down by those streams, and on the other by an accumulation of sand caused by the meeting of the marine current with that of the Yarra. The vast bar or bank of sand (now called by us Sandridge) which was thus created, appears to have been formed by separate deposits acting at long intervals, and not as many suppose, by the drift sands of the coast being carried inland, although the rising of the coast must undoubtedly have materially assisted in the formation of this remarkable sand-belt.

The shells and other organic substances in the crater, buried under the clay in the manner above described, by the process of decomposition, evolved nitrogen, hydrogen, oxygen, and sulphur; the accidental combinations of which resulted in the following chemical changes:—

1. The combination of sulphur with hydrogen.
2. The formation of hydro-sulphate of ammonia, by the combination of nitrogen, hydrogen, and sulphur. Some hydrogen being subsequently expelled, sulphate was formed, and at length sulphate of ammonia produced.
3. The formation of water by the combination of oxygen and hydrogen.

My hypothesis assumes the decomposition of sulphate of ammonia to have taken place, owing to a certain elevation of temperature, and the cotemporaneous resolution of the shells (carbonate of lime) into their constituent parts, lime and carbonic acid. The carbonic acid of the shells, combining with the ammonia, was volatilized; and the lime, uniting quickly with the sulphuric acid of the decomposed sulphate, formed *sulphate of lime* or *gypsum* ($\dot{C}a.\dot{S}.+2\,H$,) the crystalising process being effected with a rapidity commensurate with the quantity of crystalising water present. This water results from the decomposition of organic matter, as mentioned above *(vide* 3*)*, and, if present in a less ratio than 20·78 per cent, no crystals are produced.

The specimens accompanying this paper are obtained from Batman's Hill, in the neighbourhood of Melbourne. I am of opinion that gypsum might be subsequently found in considerable quantity in that locality, and if so, will become an article of commercial value, being the substance which, burnt and powdered, forms the well-known material plaster of Paris, extensively used for stuccoing buildings. When